

Final Report

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NRO review(s) completed.

1. INTRODUCTION

The CORONA J-3 Ad Hoc Committee* was informally convened by the Director, National Reconnaissance Office, on 4 December 1967 and formally constituted on 16 February 1968. The committee was established to†:

- "(1) Analyze and evaluate the effectivity of photographic flight and processing experiments performed within the CORONA program (CR-1 and CR-5 inclusive)
- (2) Recommend standard future CORONA photographic configurations resultant from the above experimental program; and,
- (3) Recommend additional CORONA photographic flight and processing experiments."

The desire for a photographic test program was directly related to the additional photographic flexibility of the CORONA J-3 camera. This flexibility is provided by two changeable filters and four changeable exposure slits on each camera, and allows the use of mixed film loads and/or different filters.

The need for the Ad Hoc Committee resulted from a desire to coordinate the test program and subsequent analysis with the community, and thereby ensure the widest possible participation.

The test program was originally proposed‡ to the D/NRO by the CIA Director of Special Projects on 11 April 1967, and was subsequently approved by the D/NRO on 15 May 1967.§

The fundamental purpose of the test series was to demonstrate the capability of the CORONA J-3 camera to handle several new photographic techniques, and, in general, that purpose was accomplished.

*CORONA Photographic Experiments Evaluation Committee.

†NRO Action Memorandum No. 16, [redacted] Feb. 16, 1967).

‡Memo for: Dr. Flax, subject: CORONA J-3 Payload Engineering Evaluations, [redacted] (Nov. 4, 1967).

§NRO message no. 6442, May 15, 1967.

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These tests fell into three general categories:

1. Those concerned with increasing the kinds of information contained in the photographic image
2. Those concerned with overcoming operational, environmental, and mechanical constraints
3. Those concerned with improving the quality of the aerial image at the film plane.

The tests that were conducted are summarized below.

Mission 1101 — Exposure Analysis. The objective of this test was to examine densitometric data acquired from CORONA photography and thereby assess the current exposure criteria, the exposure prediction techniques, and a new criterion for setting system exposure.

Mission 1102 — Bi-Color Test. The objective of this test was to determine the feasibility of obtaining color photography from the spectrally filtered black and white records.

Mission 1102 — Polarizer Test. The objective of this test was to examine the merits of photography using a polarizing filter in place of the normal red or orange filters on J-3.

Mission 1102 — SO-230 Test. The objective of this tag-on film load test was to see if the higher speed film would provide a net system performance improvement through reduced smear.

Mission 1103 — SO-380 Test. The objective of this tag-on film load test was to determine how CORONA J-3 would handle an ultrathin-base film.

Mission 1104 — [redacted] The objective of this tag-on film load test was to evaluate a [redacted] color film.

Mission 1105 — SO-121 Test. The objective of this tag-on film load test was to evaluate a conventional aerial color film in the CORONA J-3 system.

It should be noted that several tests involved color films and/or color techniques. The use of color films in the satellite systems has been, and continues to be, the source of much discussion, study, and controversy. In this regard, an attempt was made to coordinate these tests more directly with the intelligence community, i.e., every attempt was made to direct the color acquisitions toward color-oriented intelligence problems. It was hoped that in this manner we could better demonstrate the capability of the CORONA J-3 camera to handle color and also demonstrate (or deny) in some way, the intelligence utility of satellite color photography. Generally, this latter goal was not achieved, due to the manner in which the tests had to be run. This is brought out here because it was a significant problem and must be considered in any future color tests.

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The Ad Hoc Committee believes that it has served its major purpose; it is the intent of this report to summarize the tests, discuss the results, and present the committee's conclusions and recommendations. Because of the summary nature of this report, the reader may find insufficient detail on many of the tests. An attempt has been made to present only the major aspects and findings of these tests. In all cases, detailed technical reports have been issued (or will be issued shortly), and, for further information these are referenced in the body of this report. A final note of importance—although numerous tests were conducted on several missions, not one of the tests caused any failures which resulted in harm to the main intelligence purpose of these missions.

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2. CONCLUSIONS AND RECOMMENDATIONS

This section presents the major conclusions and recommendations of the Ad Hoc Committee. All the specific conclusions and recommendations found in each individual section will not be repeated here.

2.1 CONCLUSIONS

As indicated in the introduction, the major purpose of this test series was to evaluate the performance and capability of the CORONA J-3 system with several new photographic techniques/films. Hence, the first set of conclusions relates to that major purpose.

1. Bi-color is an acceptable technique for use with the J-3 camera. This conclusion relates primarily to the acquisition phase and not necessarily to its exploitation. It is clear that the use of the green filter in the AFT-looking camera does not significantly affect the normal intelligence exploitation process. While the green record does possess lower image quality and contrast, its use with the normal high resolution red (FWD-looking) record compensates for this resolution loss.

The intelligence utility of the bi-color product has yet to be clearly demonstrated, and will have to wait for the final report of the Bi-Color Committee.* However, the fact that one positive intelligence report has been issued indicates that bi-color has, at least, some value for intelligence purposes.

It must be remembered that the major drawback to bi-color is the very real difficulty associated with its exploitation process, particularly with a panoramic type camera system. There is no equipment available that is specifically built for bi-color exploitation. So long as this is the case, bi-color exploitation will be time-consuming and the results will be of significantly lower quality than desired.

*A separate committee was established to assess the intelligence utility of bi-color. This committee, known as the Bi-Color Committee, was constituted by agreement between the CIA member of the Committee on Image Requirements and Exploitation (COMIREX) and the executive officer of the National Photographic Interpretation Center (NPIC). The committee is chaired by a representative of the CIA's Office of Strategic Research and consists of two other members from NPIC.

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One of the original conceptual advantages of the bi-color process was to produce "high resolution" color through use of the high resolution black and white records. While this goal is still fundamentally possible, it has not been demonstrated due to the lack of proper exploitation equipment and the inability to produce bi-color prints in near perfect register.

Taking cognizance of the above reservations, we still conclude that bi-color is an acceptable acquisition technique for use with the J-3 camera, as long as one is aware of its current limiting problems. The use of this technique should be limited to special problems.

2. Aerial Ektachrome, SO-121, is an acceptable film for use with the J-3 camera. We believe that the test series has demonstrated the ability of the J-3 camera to employ SO-121. Ground resolutions equivalent to the best that could be expected (approximately 15 feet) have been obtained, and acceptable exposure and color balance have been demonstrated.

3. [] has not yet been demonstrated to be an acceptable film for use with the J-3 camera. We come to this conclusion out of necessity. The mission 1104 test demonstrated two undesirable effects:

- a. Severe fogging due to electrostatic discharge
- b. Loss of [] with exposure to vacuum.

The severe static marking was a direct result of a PMU* failure on the system. Ground tests indicate, however, that the static marking can be eliminated if the proper internal camera pressures are maintained. The loss of [] with exposure to hard vacuum was unexpected and unknown prior to flight. For these reasons, the mission 1104 [] test cannot be considered to have demonstrated the ability of the J-3 system to handle []. More will be said about this in the recommendations section.

4. SO-230/SO-205 films are not recommended for use in the J-3 camera. SO-230/SO-205 produces 30 percent lower 2:1 contrast resolving power than 3404/SO-380, and this is unacceptable considering the J-3 resolution/scale characteristics. Current J-3 systems have been producing 170 to 180 cycles per millimeter average low contrast resolving power in dynamic test. Certain systems, in fact, have averaged nearly 200 cycles per millimeter (lens plus film) low contrast dynamic performance. SO-230/SO-205 produces at best 190 cycles per millimeter (film alone) low contrast resolving power (as compared with 265 cycles per millimeter for 3404/SO-380) which will certainly reduce this performance level even when considering the smear reduction due to a higher emulsion speed.

*Pressure makeup unit.

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5. SO-380 (UTB) has not yet been demonstrated to be compatible for use with the J-3 system. Mission 1105 demonstrated that the combination of UTB with the J-3 camera is not clearly understood. The CORONA UTB task team* has recommended that UTB not be used again until at least September 1969, after the completion of a recommended test program. This committee agrees with that recommendation.

6. Polarizing filters are not recommended for further use in the J-3 camera with black and white films. The original intent of the polarizing filter test was to evaluate haze attenuation and reduction of specular reflections. From a practical point of view, however, the test demonstrated that the majority of haze light with respect to the spectral response of this system is not appreciably plane polarized, and that as haze gets worse, the relative amount of polarized haze light decreases. The majority of plane-polarized haze light is from the Rayleigh scatter which the normally employed spectral filters reduce anyway. Polarizing filters do not significantly reduce the effects of specular reflections from aircraft since metallic objects do not polarize light to a significant degree.

7. The testing of color films and/or techniques must be done against specific intelligence problems. There is one further conclusion that does not relate to the specific tests themselves, but to the totality of experience gained from this test program.

As pointed out in the introduction, it was not within our charter to consider the intelligence value of any of the tests. By necessity, however, we felt that it was opportune to address intelligence utility as part of the test plans.

Enough color tests have now been run to clearly demonstrate that such testing must be performed differently than black and white tests. Whereas with black and white films, it is easy to demonstrate that a lower resolution film produces less intelligence, such is not the case with color films, since it is necessary to weigh spatial resolution (i.e., cycles per millimeter) versus "spectral resolution" (i.e., color).

The discussions we have held with a limited number of intelligence analysts clearly indicate that there are intelligence problems for which color photography is uniquely suited. The several quotations in this report relative to atomic energy requirements support this conclusion. On the other hand, the discussions we have had with photo-interpreters have demonstrated their preference for the higher resolution black and white records, unless they are specifically asked to read out the color record for its color information. Considerable progress must be made in acquainting the intelligence community with the potential value of color information from aerial photoreconnaissance. More detail on this subject is contained in the recommendations section.

*See Section 9 for a discussion of the UTB task team and its purpose.

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2.2 RECOMMENDATIONS

As in the preceding section, all the specific recommendations are not reported here since they are included in the body of the report. Only our major recommendations are presented here.

1. Further testing of color films and techniques is strongly recommended. This general recommendation leads to two specific further recommendations:

- a. That further color testing should be done against specific intelligence requirements
- b. That further engineering tests with [] are indicated.

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Color in General. It is the feeling of this committee that the most important aspect of our work was that associated with the implementation of color tests on the satellite systems. However, color tests are difficult to conduct. Generally (particularly with the color films), we have conducted "end of mission" tests, i.e., the color film was placed on the end of the mission film roll. While this is a convenient and conservative way in which to run the tests, it is usually not the optimum way. This report points out that when specifically queried, intelligence analysts have identified problems for which color is uniquely suited. One cannot, however, truly evaluate the utility of color unless coverage against analysts' specific problems (targets) is acquired. For example, while the [] test plan called for photographing specific areas of China, for economic intelligence purposes, these areas were not covered because the color film was not available at that time in the orbit when coverage of these areas could be obtained. This has been a continuing problem. However, as more color film is added at the end of the mission, the higher the probability becomes that analysts' targets will be covered. The point is that the question of the utility of color film in the National Reconnaissance Program (NRP) will never be answered unless a well coordinated, concerted effort is made to acquire color photography against targets for which analysts judge it to be of benefit.

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"Regardless of these factors (i.e., the problems experienced), portions of the [] imagery obtained on this mission closely approximate the expectations of this lens/film combination. Some of the existing imagery contains significant added information from an intelligence standpoint (underlining ours), provided the analyst is allowed sufficient time to interpret it, has a working knowledge of the film characteristics, and is familiar with [] of the various objects photographed." *

2. A special subcommittee of COMIREX should be constituted to evaluate the utility of satellite color photography. The use of color for intelligence purposes is considerably more complicated, at this point in time, than black and white. The utility of color requires close cooperation between the System Program Offices, the Satellite Operations Center (SOC), the intelligence analysts, the photointerpreters, and COMIREX. Such close cooperation is not easily established. Analysts do not always know the capabilities of the systems and films, nor do the System Program Offices always understand the intelligence community's problems.

This committee is now convinced that color will, in the long run, provide significant added information for the intelligence production process. However, it is not a question of color in place of black and white, but rather a question of when color should be used, and for what kind of targets it provides additional information. The most significant fact is that this question will not be answered with a haphazard test program, run essentially at the discretion of the System Program Offices. While the System Program Offices have been most instrumental and cooperative in the planning and conducting of the color tests, they are not in a position to undertake an intensive investigation of the intelligence utility of color photography.

Further, the problem of the proper exploitation of color acquisitions is a difficult one, since the use of color is more analytical than the use of black and white. For

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[] In this case (as with many others) the cooperation between the photointerpreter and the analyst is crucial, since the meanings of colors, in an intelligence sense, are often beyond the scope of both the photointerpreter's normal job and his experience.

The point is that the color testing accomplished to date (regardless of system) has been done in a purely informal manner, with informal lines of communication established

* Mission 1104 Photographic Evaluation Report, [] (Dec. 1968).

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between the program offices, photointerpreters, and analysts. While this approach has been most effective in the past tests, further informal testing will probably be generally nonproductive in terms of answering the fundamental question concerning the determination of the targets and problems for which color provides increased information for the intelligence production process.

We strongly believe that what is now indicated is a well thought out color collection program consisting of several partial color missions on all NRP reconnaissance systems. The impetus of such a program should be to:

- a. Work closely with intelligence analysts within the community to identify specific targets and problems for which they believe color would be of value
- b. Work out a long range collection program to acquire color (on whatever system seems appropriate) against those targets and problems suggested
- c. Ensure that photointerpreter readout is coordinated with the analysts to determine if the answers the analysts were looking for are in fact provided.

We believe that only COMIREX can provide the impetus and coordination needed for such a program, but that because of its complexity, the program should be handled by a specially and specifically constituted subcommittee. We further recommend that this subcommittee be constituted of both intelligence community personnel and technical representatives of the collection community, so that maximum understanding of the problems of each group can be achieved.

3. Consideration should be given to developing specific bi-color exploitation equipment. As repeatedly stated in this report, the bi-color exploitation process is not optimum due to the lack of equipment specifically suited for this technique. It is possible that from this test of the bi-color technique, the conclusion relative to the value of bi-color in the CORONA camera system with present day reproduction equipment may be distinctly different than the assessment of the potential of bi-color per se. It is important that one does not reach the wrong conclusion for the wrong reason, i.e., one may conclude that bi-color is of little or no value, when in fact its full potential has not even been approached. Bi-color still has the fundamental advantage of ease of acquisition, which cannot be overcome with tag-on film loads of conventional color film. However, this is an advantage only if exploitation of the product could be made routinely practical.

4. Consideration should be given to the development of higher resolution color films. The only consistent objection to the use of color films is their lower spatial resolution. We believe that there would be no arguments against the use of color if it produced the same spatial resolution as black and white. This is not now technically possible, but

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the fact remains that currently available satellite color films do not represent the current state of the art of color films and considerable improvement can be made.

As with the analysis of bi-color, it is important to guard against arriving at the wrong conclusion for the wrong reason, i.e., it might well be true (although we do not so believe) that current color films are of limited intelligence value, but that higher resolution color films would be of significant value.

The fact that our major recommendations in this section relate only to color, and not to other aspects of the test program, is due to the further fact that there is no action indicated in the other areas. Generally, the other tests either fully accomplished their purpose, or the recommendations have already been implemented. However, we wish to encourage further testing of this general type on the satellite systems. The System Program Offices should be encouraged to look continually at new photographic techniques and/or films, since only in this way will we enhance our intelligence-gathering ability.

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